HHS Public Access

Author manuscript

Soc Sci Med. Author manuscript; available in PMC 2017 August 05.

Published in final edited form as:

Soc Sci Med. 2012 December ; 75(11): 2007–2012. doi:10.1016/j.socscimed.2012.07.036.

Glitch in the gradient: Additional education does not uniformly equal better health

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Abstract

While the relationship between education and general health has been firmly established in the literature, surprisingly little research has analyzed individual components of the global health judgments, such as chronic conditions or pain. We present a systematic account of the health gradient for multiple health outcomes by detailed educational categories among U.S. working-age adults. Using the 1997–2010 National Health Interview Surveys (N = 204,764), we analyze individual health outcomes ranging from cardiovascular disease to vision problems with a series of logistic regression models. The results at the presecondary and baccalaureate levels are consistent with the health gradient. An unexpected finding occurs among adults with some college but no degree, and those with technical/vocational associate degrees: these groups report more pain and a higher prevalence of a broad range of conditions than high school graduates who never attended college. We discuss several explanations for the observed patterns. The findings challenge the broadly accepted educational gradient in health; additionally, the lower postsecondary groups comprise a quarter of American adults. Jointly, there is a clear research and policy impetus to understand the source of this ‘glitch’ in the health gradient.

Keywords

Education; Health gradient; Adults; Health outcomes; USA

Introduction

An extensive body of research has documented the association between education and health. Using primarily self-rated health and all-cause mortality as outcomes, researchers have shown repeatedly that more schooling is linked to better health (Adler et al., 1994; Cutler & Lleras-Muney, 2008; House et al., 1990; Ross & Wu, 1995; Smith, 2004), slower health declines (Lantz et al., 2001; Ross & Wu, 1996), and longer life (Elo & Preston, 1996; Rogers, Everett, Zajacova, & Hummer, 2010; Zajacova & Hummer, 2009). The results have been so pervasive and persuasive that researchers have summarized them as follows:

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"Health, by any definition and by any measure, increases with the level of education" (Mirowsky & Ross, 2003).

In recent years, the literature on social determinants of health began focusing on understanding the *causal* relationships between education and health. Researchers have studied mediators like income and health behaviors through which education may affect health (Chandola, Clarke, Morris, & Blane, 2008; Conti & Heckman, 2010; Cutler & Lleras-Muney, 2008), as well as potential confounders like parental socioeconomic status or personality characteristics (Eide & Showalter, 2011; Fujiwara & Kawachi, 2009; Haas & Fosse, 2008). Another line of inquiry aimed to describe the precise *shape* of the education-health association to discern whether each additional year of schooling matters equally or whether the years associated with earning credentials are more important (Ross & Mirowsky, 1999; Schnittker, 2004; Zajacova, Hummer, & Rogers, 2012). These studies, using newly available data with detailed educational categories, still typically used global measures of health such as self-rated health and generally also found a uniformly positive relationship between schooling and health status.

An important aspect of the education-health research has been curiously neglected: the examination of individual components of the global health status, such as chronic conditions or pain. Health is a complex multidimensional construct and it is critical to understand which specific health problems drive the gradient, both to posit causal explanations and ultimately to design and implement policies to decrease the health inequalities in the population. In the epidemiological literature, there is a sizeable body of research on socioeconomic status (SES) and individual outcomes, such as prevalence rates for specific conditions. Many of these studies, however, used occupation, neighborhood poverty level, income, or other measures to capture the respondents' place in the SES hierarchy. Moreover, the studies typically targeted a clinically-meaningful population such as the elderly or patients with some illness, rather than the general population.

Among the relatively few studies on the association between education and specific health conditions or problems, most reported the expected inverse link whereby higher education was associated with lower prevalence rates of diabetes (Mezuk, Eaton, Golden, & Ding, 2008; Smith et al., 2011), hypertension (Grotto, Huerta, & Sharabi, 2008; Liu et al., 2011), cardiovascular disease (Winkleby, Kraemer, Ahn, & Varady, 1998), or pain measures such as back pain or migraines (Latza, Kohlmann, Deck, & Raspe, 2004; Le, Tfelt-Hansen, Skytthe, Kyvik, & Olesen, 2011). There were exceptions where the SES gradient was weak or positive, as in some studies of emphysema (Lovasi et al., 2011), melanoma (Harrison, Haque, Roseman, & Soong, 1998), and breast cancer (Vanloon, Goldbohm, & Vandenbrandt, 1994).

Nearly all of these epidemiological analyses, however, either forced a linear specification of education or trichotomized it as presecondary, secondary, and postsecondary. The linear specification only shows the general trend across all levels of schooling. Trichotomizing, especially for the postsecondary level, is problematic at a time when the majority of the population falls into this single broadly-defined category (Planty et al., 2009). Doing so

obscures differences between adults with just a few college credits and those with professional/doctoral degrees.

The motivation for this study was to analyze the gradient for multiple health measures—from cardiovascular and chronic respiratory conditions to vision problems and functional limitations—across detailed educational-attainment levels. We examined health gradients for 10 specific outcomes, as well as self-rated health, across a set of nine educational categories in a large, nationally representative sample of working-age adults. We thus contribute both to the epidemiological literature by adding detailed educational attainment information to the analysis of specific health outcomes, as well as to the social determinants literature by focusing on multiple dimensions of the general health status.

Data and methods

Data

The analyses were based on data from the 1997–2010 National Health Interview Surveys (NHIS). The NHIS is an ongoing annual household survey conducted through face-to-face interviews by the National Center for Health Statistics. The NHIS uses a complex multistage stratified sampling design to obtain a sample representative of the civilian non-institutionalized U.S. population. We obtained the data through the Integrated Health Interview Surveys (IHIS), a consolidated source of NHIS data compiled by the Minnesota Population Center (2008). Since a major redesign of NHIS in 1997, the sample design and the core questions have remained identical from year to year. The unconditional response rates for Sample Adults, the group used for the analyses, which comprised a single randomly-selected individual from each sampled household, exceeded 80% in 1997 although it declined to 61% in 2010 (NCHS, 2011).

The analysis sample was defined as U.S.-born adults age 30 to 64 who provided valid education information (N = 204,764). For the lower age threshold, 30 was optimal because over 10% of adults age 25–29 are still enrolled in school so their attainment information is unavailable, whereas fewer than 5% are enrolled past age 30 (Planty et al., 2009). The upper boundary is the typical age of transition to retirement; jointly, they define working-age adults with completed schooling. Among U.S.-born respondents aged 30–64, only 1664 (0.8%) were missing education information, so their exclusion is unlikely to bias the results.

Variables

Educational attainment—Information about schooling was collected identically in all interview waves as the highest completed year up to the 12th grade and as educational credentials for those who completed at least high school. During the interview, respondents were handed a card with a list of educational categories and asked to select the one that best represented their level. Due to the relatively small numbers, we collapsed master's and doctoral degrees as MA+, grades 0–8 as grade-school level and grades 9–10 and 11–12 as high school dropout categories. The latter group included adults with the General Educational Development (GED) diploma, a group of adults who have been found comparable to high school dropouts in terms of health outcomes (Zajacova, 2011). All other

credentials were retained in the original detail (high school = referent). “Some college” includes adults who attended college but did not earn any postsecondary credential. There are two types of associate degrees, both requiring about 60 credit-hours of study. The first is a technical/vocational degree that prepares students directly for specific occupations, such as paralegal, computer or lab technician, medical transcriptionist, or a teacher’s aide. The second type is academic, sometimes referred to as a transfer associate degree, designed to provide the first two years toward a bachelor’s degree.

Health measures—All measures were self-reported by the respondents. We included 10 specific health outcomes and self-rated health. All were dichotomized and coded as 0 if respondent did not report the outcome and 1 if they reported it. The health outcomes included: 1) cardiovascular conditions comprising angina pectoris, coronary heart disease, heart attack, or other heart conditions; 2) respiratory conditions, which included chronic bronchitis and emphysema; 3) hypertension; 4) diabetes; 5) back or neck pain; 6) facial pain or severe migraine; 7) acute conditions comprising a cold or an intestinal illness during the previous two weeks; 8) current vision problems asked in terms of “having any trouble seeing, even when wearing glasses of contact lenses; ” 9) other conditions that included kidney problems, liver disease, and stomach problems or ulcer; and 10) functional limitations, including any difficulty pushing or pulling large objects, shopping or going to the movies or other events, participating in social activities, doing other things for leisure, walking up to 10 steps without resting, or standing for 2 h. Self-rated health was dichotomized and coded 0 if the respondent indicated excellent, very good, or good health, and 1 for fair or poor health. Most conditions were ascertained with the following question: “Have you been told by a doctor or other health professional that you had [this condition]?” The pain questions were phrased as “During the past 3 months, have you experienced pain in [this body part]?” Some conditions (i.e., cardiovascular) were combined because of their relatively low prevalence and to simplify the presentation of findings.

Tetrachoric correlations among all 55 pairs of outcomes were low to moderate, averaging $r = 0.32$. Only a single correlation—between functional limitations and self-rated health—exceeded 0.6 (tetrachoric $r = 0.65$; all correlation results available on request). This indicates that each outcome carried unique information about the respondents’ health, justifying the estimation of the multiple models.

Controls—All logistic models controlled for age (in single years, centered on the sample mean of 46 years), sex, race (non-Hispanic white = referent, non-Hispanic black, Hispanic, and other), and survey year (centered on the mean year of 2003).

Analysis

We estimated a series of logistic regression models of each health outcome on education, controlling for basic covariates. The estimation adjusted for the complex sampling design using the svy suite in Stata 11 (StataCorp, 2009).

In addition to models shown here, we also estimated a comparable series of models stratified by sex, age (two age groups, 30–44 and 45–64), race (white and nonwhite), and time period (1997–2003 and 2004–2010). The aim was to ensure that the findings were consistent across

groups, which could be obscured in the total-sample models. These auxiliary analyses showed that the findings and conclusions presented below held for all major population subgroups. The results are available on request.

Results

Table 1 shows the distribution of the educational attainment in the sample, as well as the prevalence of all health outcomes and basic sample characteristics by education. The modal educational attainment was a high school diploma (26%); nearly 31% of the sample was classified as 'subbaccalaureate' segment, encompassing some college or an associate degree. Another 30% earned at least a bachelor's degree. The prevalence ranged from about 6% for respiratory conditions, comprising chronic bronchitis and emphysema, to 36% for back or neck pain.

Table 2 displays results for demographics-adjusted logistic models of ten health outcomes and self-rated health. For parsimony, the table omits precise *p*-values and confidence interval information, which are available on request. The reference category is high school diploma. Results can be easily recalculated for a different referent (for instance, master's degree or more) by dividing each odds ratio by the odds ratio of the desired referent (i.e., for cardiovascular disease, OR = 0.79 for the MA + category in the original models so adults with 0–8 years of schooling have 2.16/0.79 = 2.75 times the odds of reporting a cardiovascular condition, compared to adults with the highest education.)

In all 11 models, adults with less than high school diploma were more likely to report the given health problem than high school graduates. There was a step-like pattern where the odds ratios for adults with 0–8 years of schooling were greater than the odds ratios for adults with 9–10 years, which were in turn greater than the odds ratios for adults with 11 or 12 years of schooling. This pattern was consistent with the health gradient. At the baccalaureate and higher educational levels, results also corroborated the expected gradient. For all 11 outcomes, respondents with at least a bachelor's degree reported significantly lower odds of health problems than high school graduates.

The results were quite different at the subbaccalaureate level, which included adults with some college but no diploma and those with associate degrees. College dropouts were significantly *more* likely or at least equally likely to report all conditions except fair or poor self-rated health, compared to high school graduates. For instance, the odds of reporting a cardiovascular condition and back or neck pain were 14% and 15% higher, respectively, among college dropouts than the odds for high school graduates. The only exception was self-rated health: compared to the odds for high school graduates, the odds of reporting poor or fair SRH were 16% lower for those with some college.

Adults with a technical/vocational associate degree were fairly similar to college dropouts in that they also reported more or at least a similar level of health problems as high school graduates. Interestingly, adults with an academic associate degree tended to report a lower prevalence of health problems than their technical/vocational associate degree peers. For about half of the outcomes, the odds were comparable between the academic associate

degree level and the high school reference; for another half of the outcomes, the respondents with an academic associate degree had lower odds than high school graduates.

We also estimated sex-, age-, race-, and period-stratified models that are not shown but are available on request. Excepting self-rated health, there were 80 models of health outcomes (10 outcomes estimated for eight groups), each with two coefficients associated with the 'some college' and technical/vocational associate degree levels. Of those 160 coefficients, only a single one (for hypertension in race-stratified models among white adults with 'some college' education) was consistent with the gradient in that it showed adults with some college to have lower odds of reporting this condition than high school graduates.

Discussion

This study determined the health gradient for multiple specific outcomes across detailed educational categories. While numerous articles have studied the association between education and *global* health status, typically measured with self-rated health, surprisingly little research has examined the gradient for individual health conditions. This omission is problematic if we want to truly understand the links between schooling and health. Health is a complex construct, so disaggregating the global measures into their individual components, such as chronic conditions or pain, is necessary to understand what drives the overall patterns.

For most educational levels, our findings corroborated literature and corresponded to the health gradient. Adults who did not complete high school reported uniformly more health problems than high school graduates. Adults with a bachelor's or master's degree reported considerably fewer health problems than high school graduates.

The major finding was a 'glitch' in the health gradient for adults with some college education, as well as recipients of technical/vocational associate degrees. Although these groups had more schooling than high school graduates, they reported at least as many health problems and conditions—ranging from cardiovascular and respiratory conditions to acute illness, pain, and functional limitations—as the high school graduates. This unexpected result prompts several questions. First, why do these lower-postsecondary groups fail to conform to the health gradient? And second, why do they report a similar or higher prevalence of all the studied conditions than high school graduates, but better self-rated health?

One reason why adults with some postsecondary education report more conditions than high school graduates might be due to reporting bias: adults with additional education may be more likely to visit a doctor, receive a diagnosis, and remember it. However, pain measures were among the strongest outcomes in terms of the 'glitch,' and the respondents do not need a doctor's diagnosis to report pain. An additional argument against the reporting bias as an explanation for the 'glitch' is that if the results were due to a differential knowledge about conditions, we could expect adults with less than high school to visit doctors less and be less knowledgeable than high school graduates. This would imply a lower prevalence rate of the

reported conditions at the pre-secondary levels, while we found the opposite, a significantly higher prevalence, fully consistent with the health gradient.

Assuming the 'glitch' does not result from reporting differences, we may want to understand how much of this pattern is causal from schooling to health, versus confounded by unobserved characteristics of the subbaccalaureate groups, or even resulting from reverse causality whereby health problems prevented the college dropouts from reaching their educational goals or impacted the choice to earn a technical/vocational associate degree. Although the data and space constraints do not permit analyzing these questions in a systematic way, we draw on existing literature to posit several explanations, which can be tested in future studies.

When considering the possibility that the subbaccalaureate educational attainment somehow causes the worse-than-expected health outcomes, we would want to understand whether the 'glitch' may be explained by differences in the major pathways known to convert educational attainment into health. Extensive literature (Adler & Ostrove, 1999; Chandola et al., 2008; Cutler & Lleras-Muney, 2008; Eide & Showalter, 2011; Lantz et al., 2001; Mirowsky & Ross, 1998, 2003; Ross & Wu, 1995) has documented that health behaviors such as smoking, economic characteristics including employment, income, and wealth, as well as psychosocial factors all contribute to explaining the links between education and health. While a thorough examination of such pathways is beyond the scope of the current paper, some preliminary analyses suggest that the 'glitch' is not explained by smoking, obesity, alcohol use, employment status, family income, and a small number of additional potential explanatory factors. We strongly urge further research in this direction.

We do not expect reverse causality to be a driving explanatory factor of the observed 'glitch' for two reasons. First, while poor childhood health may impact educational attainment (Haas & Fosse, 2008; Jackson, 2009), the effects are relatively weak (Case, Fertig, & Paxson, 2005; Palloni, Milesi, White, & Turner, 2009; Smith, 2009). Additionally, extensive educational literature spanning decades has identified critical determinants of educational attainment to be family background and cognitive and noncognitive skills; however, early health does not appear in this literature at all (Cameron & Heckman, 1999, p. 89; Kao & Thompson, 2003; Marjoribanks, 2005; Ou & Reynolds, 2008; Portes & Wilson, 1976; Sewell, Haller, & Ohlendorf, 1970). Most importantly, it is unlikely that the reverse causation would act selectively on only two educational groups (college dropouts and those with technical/vocational associate degrees). Second, the glitch appears for acute conditions like colds or intestinal problems experienced during two weeks preceding the interviews, and for pain experienced during the three months preceding the interview. We realize, of course, that we cannot definitively exclude the possiblitity of long-term compromised health status that would first curtail the respondents' educational trajectories and later also cause the presence of these health outcomes. The reverse-causality explanation could be tested if the data included the age of onset for the conditions or information about childhood and adolescent health, which we encourage NCHS to collect in the future.

Finally, some of the 'glitch' could be due to confounding, meaning that unobserved characteristics drive both educational attainment and health outcomes. Compared to students

attending 4-year colleges, subbaccalaureate students come from more disadvantaged backgrounds in terms of their parents' lower income and education and they perform worse on standardized tests, suggesting lower cognitive skills (Bailey et al., 2003). Interestingly, although we found differences between the two types of associate degrees, the literature suggests that students pursuing these two types of credentials are rather similar in sociodemographic characteristics (Hudson, Kienzl, & Diehl, 2007). The influence of skills and background, and possibly of the institutions where the degrees are earned, may be explored using data sources like the National Longitudinal Surveys of Youth.

The second question raised by the unexpected 'glitch' pertains to the discrepancy between self-rated health and all other outcomes: why do the adults with some college and technical associate degrees report more health problems but better self-rated health? The self-rated health judgment likely includes conditions and health problems that we did not study, such as mental-health indicators. If the omitted measures had lower prevalence in the subbaccalaureate groups, that could help explain the discrepancy. Future studies could analyze additional measures, like depression scores, to test this possibility. Alternatively, the lower-postsecondary groups may form health judgment in a fundamentally different way than other groups. Several recent studies (Dowd & Zajacova, 2010; Zajacova & Dowd, 2011) suggested that SES groups differ in the way they assess their health but they do not provide detail that would allow us to resolve the discrepancy. This could also be a fruitful avenue for future research.

We mention three limitations. First, all conditions were self-reported. Self-reports of health status are widely accepted in population health research; nonetheless, they may vary across respondents with different levels of education. Future studies could address the possible reporting issues by using such objective outcomes as biomarkers, which are not available in NHIS. A second limitation is that the data did not include information on the quantity or quality of schooling. If we knew how many college credits the dropouts earned, for instance, we could determine whether more schooling at this level was associated with fewer health problems. Quality of schooling information would also be desirable; perhaps the quality of education among the college dropouts was lower than among those who graduated, compounding the disadvantage of fewer years by lesser quality. And finally, the data did not allow us to explore why the academic and technical/vocational associate degrees differ. An academic associate degree is sometimes considered a 'transfer' degree, with recipients expected to continue to a 4-year degree. In that respect, they are more similar to college dropouts in that they did not complete the intended bachelor's degree; however, our findings showed that they were better off than recipients of the technical/vocational degree. Alternatively, technical/vocational associate degree may train for more physically demanding careers, compared to academic associate, which could lead to chronic back pain and more functional limitations. Occupational data could be used in future studies to explore whether the discrepancy in the two types of associate degree can be explained by different employment paths.

Conclusion

Although higher education is generally associated with better health, our study uncovered an unexpected glitch in the gradient: adults with lower postsecondary educational attainment report more or at least no fewer health problems than high school graduates who never attended college. This lower-postsecondary group represents about a quarter of the total adult population and is expected to grow over time (Crissey, 2009). Our findings challenge the broadly accepted educational gradient in health and underscore the need for both researchers and policymakers to examine detailed educational categories in public-health research.

Acknowledgments

We thank the Eunice Kennedy Shriver NICHD-funded University of Colorado Population Center (grant R24 HD066613) for administrative and computing support, and the National Center for Health Statistics (NCHS) for collecting the data and making the linked files available to the research public. We also thank the Minnesota Population Center for creating and maintaining the Integrated Health Interview Series. The content of this manuscript is solely the responsibility of the authors and does not necessarily represent the official views of NIH, NICHD, or NCHS.

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Soc Sci Med. Author manuscript; available in PMC 2017 August 05.

Table 1

Sample characteristics and prevalence of health conditions, by education.

	Total	Less than high school	High school diploma	Some college or AA	Bachelor's or more
Education					
0–8 years	2.2%				
9–10 years	3.6%				
11–12 years or GED	7.6%				
High school diploma	26.1%				
Some College	19.3%				
AA – vocational/technical	7.5%				
AA – academic	3.9%				
BA/BS	19.1%				
MA/MS or higher degree	10.7%				
Health conditions					
Cardiovascular	10.0%	15.4%	9.8%	10.2%	7.7%
Respiratory	6.2%	11.9%	6.3%	6.5%	3.3%
Hypertension	26.0%	35.5%	28.1%	25.9%	19.9%
Diabetes	7.7%	12.9%	8.5%	7.7%	4.6%
Back or neck pain	36.1%	45.4%	35.8%	38.5%	29.7%
Migraine or facial pain	19.9%	26.2%	18.7%	21.9%	16.2%
Acute conditions	16.5%	20.8%	15.8%	16.8%	14.9%
Vision problems	9.9%	16.5%	9.8%	10.2%	6.8%
Other conditions	10.8%	17.8%	10.7%	11.4%	6.9%
Functional limitations	33.2%	49.3%	34.5%	34.6%	23.6%
Fair or poor SRH	12.4%	31.2%	13.8%	10.9%	4.3%
Control variables					
Age – mean (s.e.)	46.0 (0.03)	47.3 (0.07)	46.7 (0.05)	45.5 (0.05)	45.4 (0.05)
Female	54.0%	52.0%	53.5%	56.6%	52.6%
Race					
White	81.1%	69.7%	80.4%	80.1%	87.9%
Black	12.8%	20.4%	14.1%	13.5%	7.6%

	Total	Less than high school	High school diploma	Some college or AA	Bachelor's or more
Hispanic	4.4%	8.0%	4.2%	4.7%	2.6%
Other	1.7%	1.9%	1.4%	1.7%	1.8%

Note: AA = associate degree, BA/BS = bachelor's degree, MA/MS = master's degree. Cardiovascular conditions include angina pectoris, heart attack, coronary heart disease and other heart conditions.

Respiratory conditions include chronic bronchitis and emphysema.

"Other" conditions include kidney or liver problems, or stomach problems or ulcers. Source: NHIS 1997–2010, U.S.-born adults age 30–64, *N* = 204,764. Adjusted for sampling design.

Table 2

Logistic models of health outcomes on education.

	Cardio-vascular	Respiratory	Hyper-tension	Diabetes	Back or neck pain	Migraine/facial pain	Acute conditions	Vision problems	Other conditions	Function. limitations	Poor or fair SRH
Education											
0–8 years	2.16***	2.75***	1.46***	1.85***	1.71***	2.24***	1.60***	2.38***	2.34***	2.64***	4.92***
9–10 years	1.71***	2.16***	1.38***	1.44***	1.64***	1.69***	1.52***	1.78***	1.88***	2.09***	3.19***
11–12 years	1.46***	1.84***	1.26***	1.33***	1.44***	1.47***	1.33***	1.60***	1.62***	1.63***	2.05***
High school											
Some college	1.14***	1.12***	0.97	0.98	1.15***	1.16***	1.07***	1.09***	1.13***	1.07***	0.84***
AA - technical	1.18***	0.99	0.97	0.94	1.13***	1.18***	1.04	1.07	1.09*	1.06**	0.78***
AA - academic	0.99	0.86*	0.92**	0.85**	0.99	1.06	1.02	0.92	1.00	0.88***	0.54***
BA/BS	0.84***	0.55***	0.71***	0.59***	0.74***	0.79***	0.92***	0.72***	0.65***	0.63***	0.33***
MA/MS or more	0.79***	0.47***	0.65***	0.54***	0.74***	0.81***	0.92**	0.67***	0.61***	0.56***	0.25***
Control variables											
Age	1.06***	1.03***	1.07***	1.07***	1.01***	0.98***	0.99***	1.03***	1.03***	1.05***	1.05***
Female	0.98	1.85***	0.86***	0.93***	1.22***	2.55***	1.17***	1.38***	1.09***	1.52***	1.13***
Race											
Black	0.95*	0.77***	1.96***	1.80***	0.70***	0.79***	0.94*	1.14***	0.89***	0.94***	1.81***
Hispanic	0.76***	0.66***	1.02	1.75***	0.84***	0.90***	0.92**	1.07*	0.90**	0.89***	1.29***
Other	1.16*	1.24**	1.41***	2.03***	0.96	1.10*	1.05	1.44***	1.24***	1.20***	1.69***
Survey year	1.00	1.00	1.03***	1.05***	1.00	1.01***	1.00	1.01***	0.99**	1.01***	1.03***

*$p < .05$

**$p < .01$

***$p < .001$.

Note: AA = associate degree, BA/BS = bachelor's degree, MA/MS = master's degree. Source: NHIS 1997–2010, U.S.-born adults age 30–64, $N = 204{,}764$. Adjusted for sampling design.